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भाग 5 खुले परिपथ वोल्टेज पद्धति द्वारा प्रकाशवोल्टीय (पी वी) युक्तियों का तुल्य तापमान ज्ञात करना

Indian Standard

PHOTOVOLTAIC DEVICES

PART 5 DETERMINATION OF THE EQUIVALENT CELL TEMPERATURE (ECT) OF PHOTOVOLTAIC (PV) DEVICES BY THE OPEN-CIRCUIT VOLTAGE METHOD

ICS 27.160

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January 2010 **Price Group 1**

Solar Photovoltaic Energy Systems Sectional Committee, ETD 28

NATIONAL FOREWORD

This Indian Standard (Part 5) which is identical with IEC 60904-5 :1993 'Photovoltaic devices — Part 5: Determination of the equivalent cell temperature (ECT) of photovoltaic (PV) devices by the open-circuit voltage method' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Solar Photovoltaic Energy Systems Sectional Committee and approval of the Electrotechnical Division Council.

The text of the IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker in the International Standard while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain international Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their respective places are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60891 : 1987 Procedures for temperature and irradiance corrections to measured I-V characteristics of crystalline silicon photovoltaic devices	IS 12763 : 1989 Procedures for temperature and irradiance corrections to measured I-V characteristics of crystalline silicon photovoltaic devices	Identical
IEC 60904-1 : 1987" Photovoltaic devices — Part 1: Measurements of photovoltaic current-voltage characteristics	IS 12762 (Part 1) : 2010 Photovoltaic devices: Part 1 Measurement of photovoltaic current-voltage characteristics *(first revision)*	Technically Equivalent

Only the English language text of the International Standard has been retained while adopting it in this Indian Standard, and as such the page numbers given here are not same as in the IEC Standard.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test, shall be rounded off in accordance with IS 2 :1960 'Rules for rounding off numerical values (rev/secO*. The number of significant places retained in the rounded off value should be the same as that of the specified value in the standard.

"Since revised in 2006-

IS 12762 (Part 5) : 2010
IEC 60904-5 :1993

Indian Standard

PHOTOVOLTAIC DEVICES

PART 5 DETERMINATION OF THE EQUIVALENT CELL TEMPERATURE (ECT) OF PHOTOVOLTAIC (PV) DEVICES BY THE OPEN-CIRCUIT VOLTAGE METHOD

1 Scope and object

This part of IEC 904 applies to crystalline silicon devices only.

It describes the preferred method for determining the equivalent cell temperature (ECT) of PV devices {cells, modules and arrays of one type of module), for the purposes of comparing their thermal characteristics, determining NOCT (nominal operating cell temperature) and translating measured l-V characteristics to other temperatures.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 904. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agree~ ments based on this part of IEC 904 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 891**:** 1987, *Procedures for temperature and irradiance corrections to measured l-V characteris tics o 1 crystalline silicon photovoltaic devices*

IEC 904-1: 1987, *Photovoltaic devices* - *Part 1: Measurement of photovoltaic current-voltage characteristics*

3 Equipment

The following equipment is required:

- a calibrated radiation sensor, such as a reference device (preferred) or a pyrano-meter;
- means to measure the open-circuit voltage to a precision better than ±0,5 %.

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4 Procedure

a) If not already known, determine the temperature coefficient (β) of the open-circuit voltage of the device, either from cell measurement in accordance with IEC 891 or from module measurement in accordance with the appropriate IEC publication (under consideration).

b) If not already known, determine the open-circuit voltage (V_{oc1}) of the device at standard test conditions or some other reference conditions *(E1, T1)* in accordance with IEC 904-1.

c) Mount the radiation sensor coplanar with the device.

d) Take simultaneous readings of the open-circuit voltage of the device (V_{0C2}) and the incident irradiance (*E2).*

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e) Calculate the equivalent cell temperature, *ECT*, as follows:

$$ECT = T2 = T1 + \beta^{-1}\,[V_{OC2} - V_{OC1} + D \times ns \times \ln(E1/E2)]$$

where

ns is the number of cells in series

D is the diode thermal voltage = *Ak* (*T2* + 273) / *q*

A is the diode quality factor

k is the Boltzmann constant ($1{,}38 \times 10^{-23}$ J/K)

q is the elementary charge of an electron ($1{,}6 \times 10^{-19}$ As)

$$T2 = (A1 + A2 \times 273) / (1 - A2)$$

where

$$A1 = T1 + \beta^{-1}\,(V_{OC2} - V_{OC1})$$

$$A2 = \beta^{-1} \times (Ak/q) \times ns \times \ln(E1/E2)$$

NOTE – If *A* is not known, *D* should be determined by measuring the open-circuit voltages V_{OC3} and V_{OC4} of a typical cell or module at two different irradiances, *E3* and *E4* respectively, in the range of interest and at the same cell temperature.

Then:

$$D = \frac{1}{ns} \times \frac{V_{OC4} - V_{OC3}}{\ln(E4/E3)}$$

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard alongwith amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

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Amendments Issued Since Publication

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